

Choosing metal in seismic areas

A research project into the seismic performance of fabricated steel may lead to lower costs and potentially a change in the standard.

HERA IS FACILITATING seismic research in metals, providing confidence that New Zealand-fabricated steel products are a very safe building material choice for our seismic environment. Many seismic research projects are under way.

Welding – a key project

A key project in conjunction with the Universities of Auckland, Canterbury and Michigan is seismic weld performance research. Its objective is to improve the cost-effectiveness of steel structure fabrication by optimising weld details such as type of welds and penetration for moment-resisting connections (MRCs) in carbon and stainless steel.

The programme involved large-scale testing of moment-resisting frames and smaller welded samples and assessment of low-cycle fatigue. It utilises advanced design procedures for dimensioning of fillet and partial-penetration welds. These ensure the resilience of metals in seismic environments while minimising fabrication costs.

The performance of steel buildings in quakes

Most modern multi-storey steel structures in New Zealand are designed using moment

frames, eccentrically braced frames or a combination of both. They are typically built using shop welding and site-bolting construction.

In the Canterbury earthquakes, although the shaking was significantly greater than the design level, steel buildings behaved very well. They not only satisfied their life safety mandate but were occupiable shortly after the earthquake.

New Zealand seismic connection details were last evaluated after the Northridge and Kobe earthquakes. A systematic review of the commonly used connection details would enable the New Zealand steel construction industry to reduce fabrication costs and performance improvements.

Design criteria and recommended steel connection details for seismic connections are given in NZS 3404.1 *Steel structures standard* and the Steel Construction New Zealand (SCNZ) *Steel construction guide* SCNZ 14.1 and 2. The basis for these recommendations was large-scale testing by HERA in collaboration with the University of Auckland.

A feature of the SCNZ guide is that fillet welds and partial penetration welds can be specified for all connections including MRCs.

Although fillet welds are more economical than full-penetration butt welds in MRC up to

the leg size of 25-30 mm, the cost escalates with increasing weld size.

Partial-penetration butt welds are cheaper to fabricate than large fillet welds for thick flanges due to the reduced weld metal volume. However, the trend following the earthquakes has been to specify the more expensive full-penetration butt weld connections.

Standard likely to be revised

The current focus in the 3-year programme is low-cycle fatigue performance of steel connections, alternative and ancillary weld details and tolerances.

We know from Christchurch that misalignment affects performance, especially once it exceeds half the thickness of the incoming flange. However, we don't know the extent of smaller and more frequent misalignments. Further research is investigating potential benefits from the use of overstrength weld metal in fillet welds and influence of the thermal cutting and quality on the joint performance.

Due to this research, some welding requirements of the standard are likely to be revised, making fabrication more economical while retaining structural steel's seismic performance. ◀